

PERFORMANCE ASSESSMENT OF ROCK ANCHORS

Session Leaders

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Half-Cell Potential Test

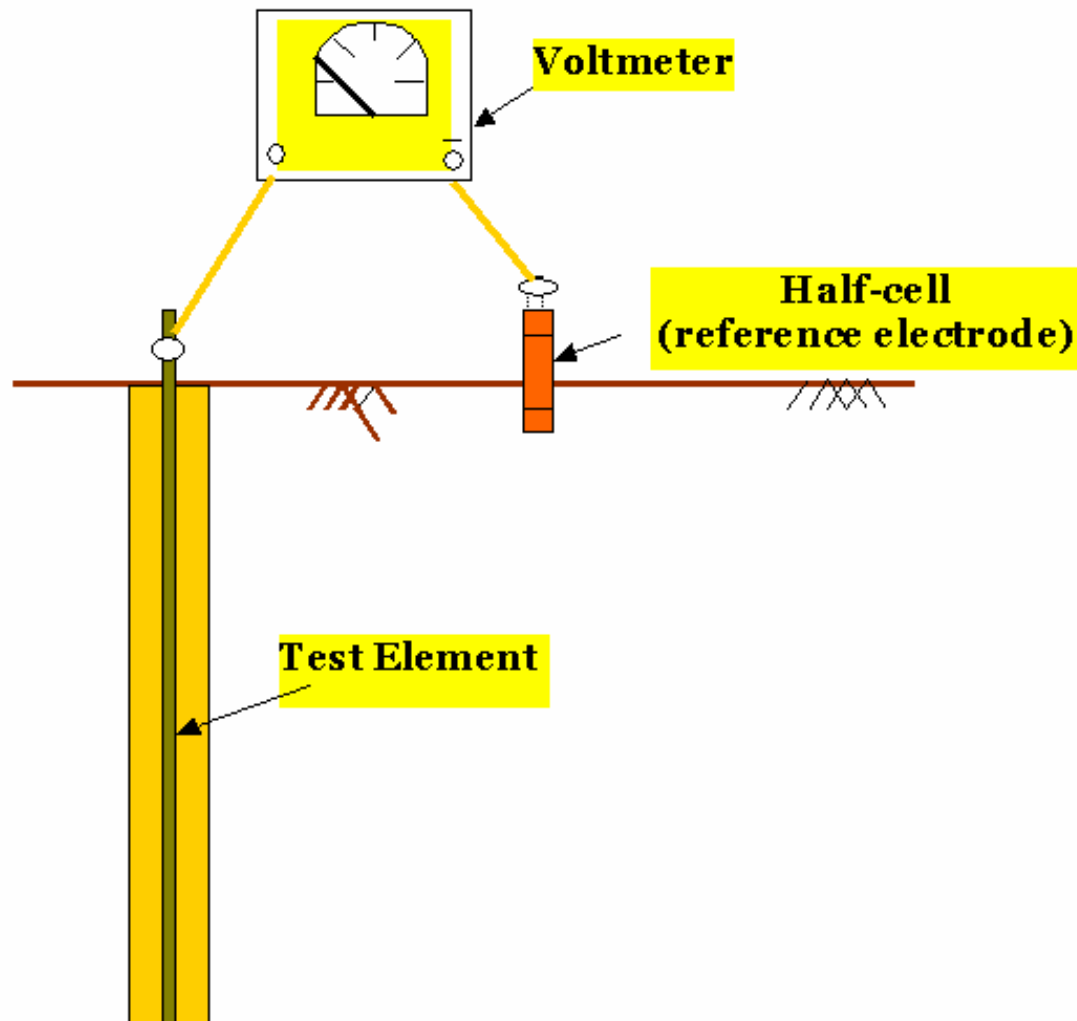
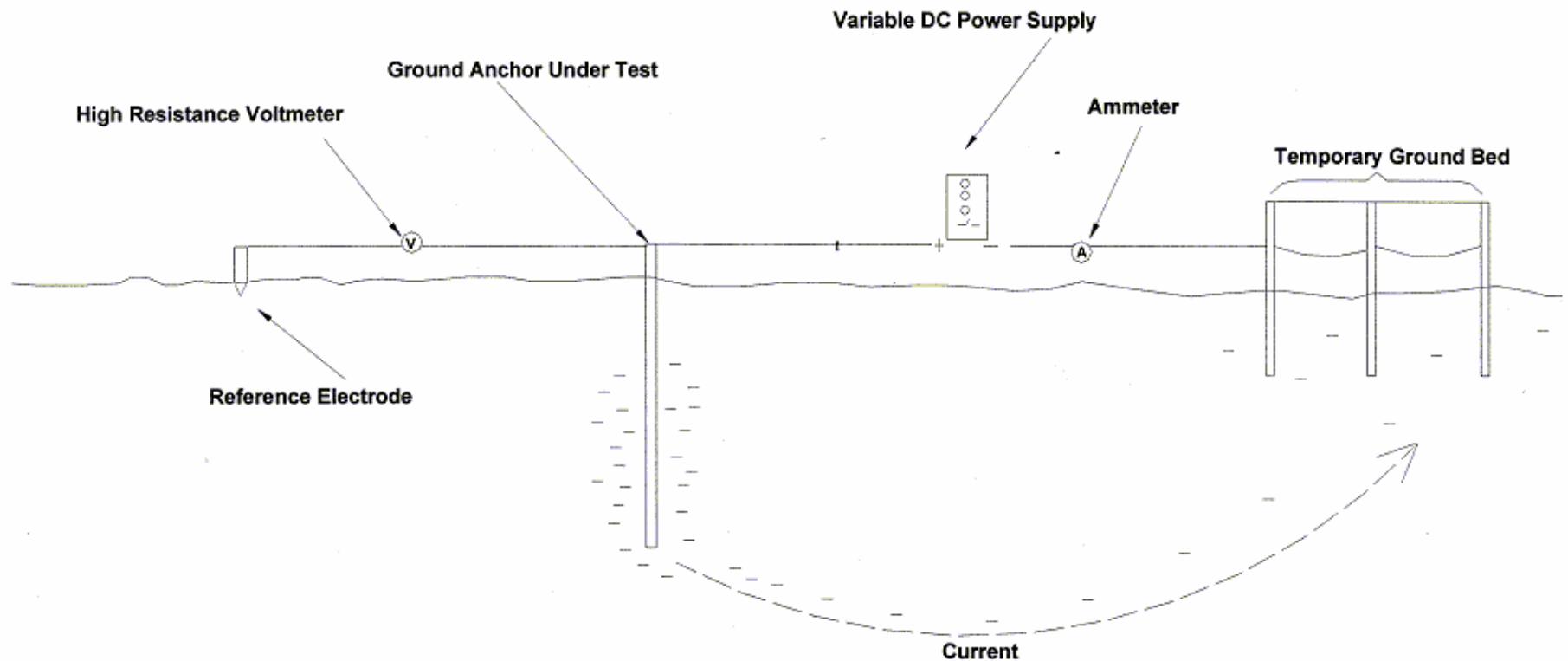


Photo of Half-Cell Potential Test



Set-up for Polarization Current Test



Typical Measurement from Polarization Current Test

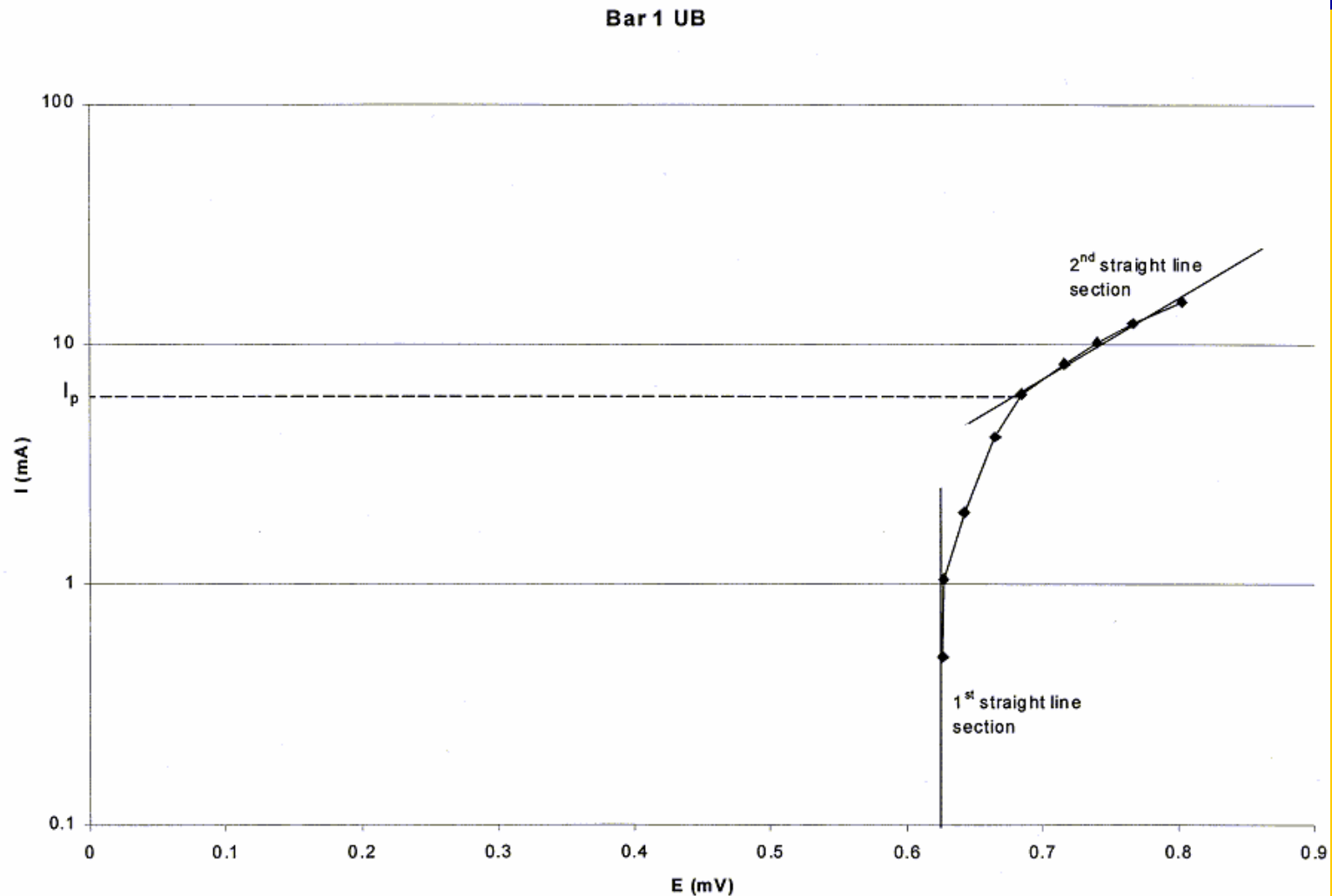


Photo of Polarization Current Test



Schematic of Impact Echo Test

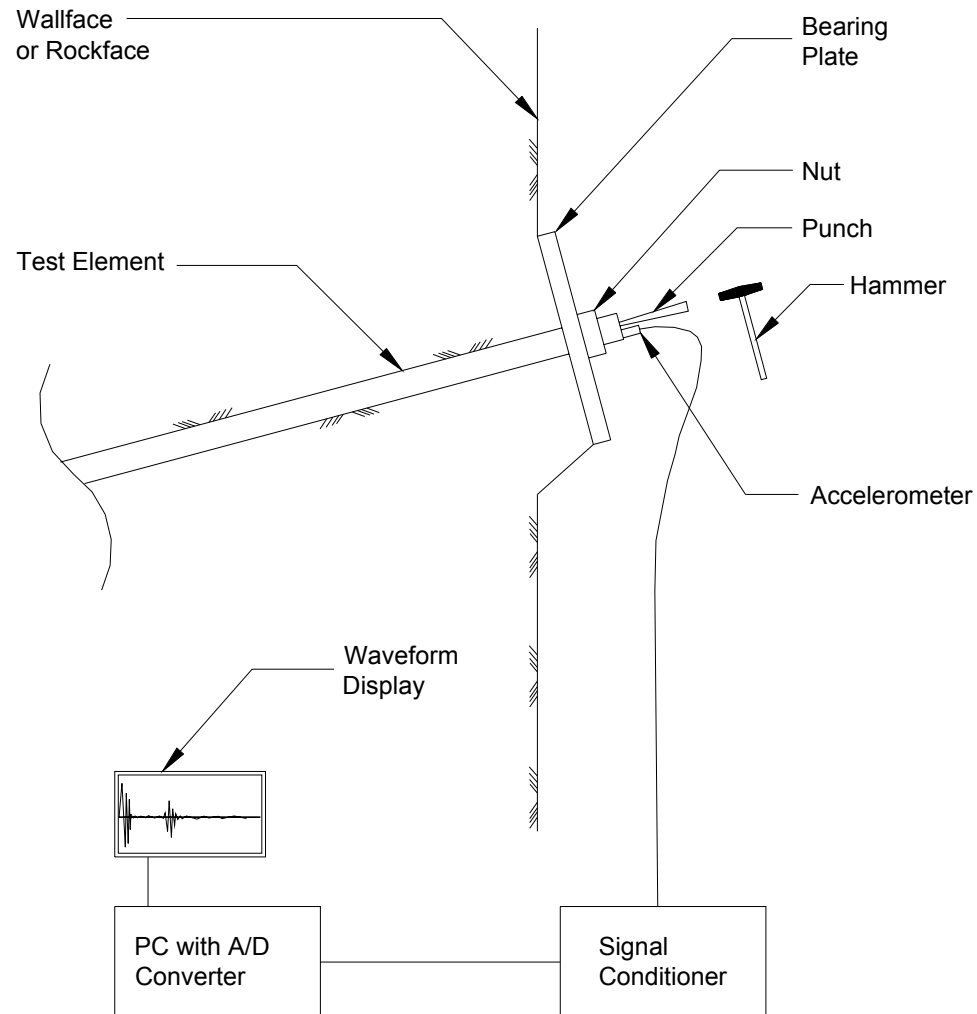


Photo of Impact Echo Test



Instrumentation Set Up



Schematic of Ultrasonic Test

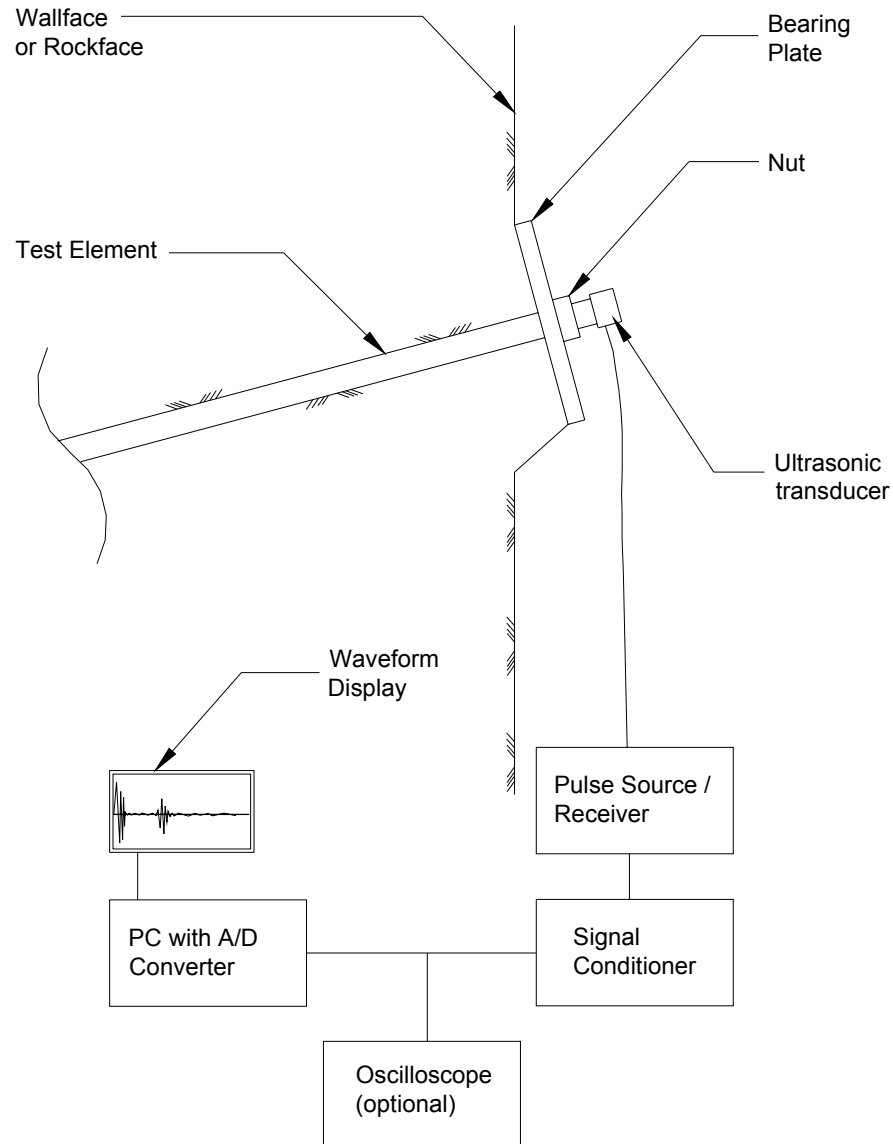


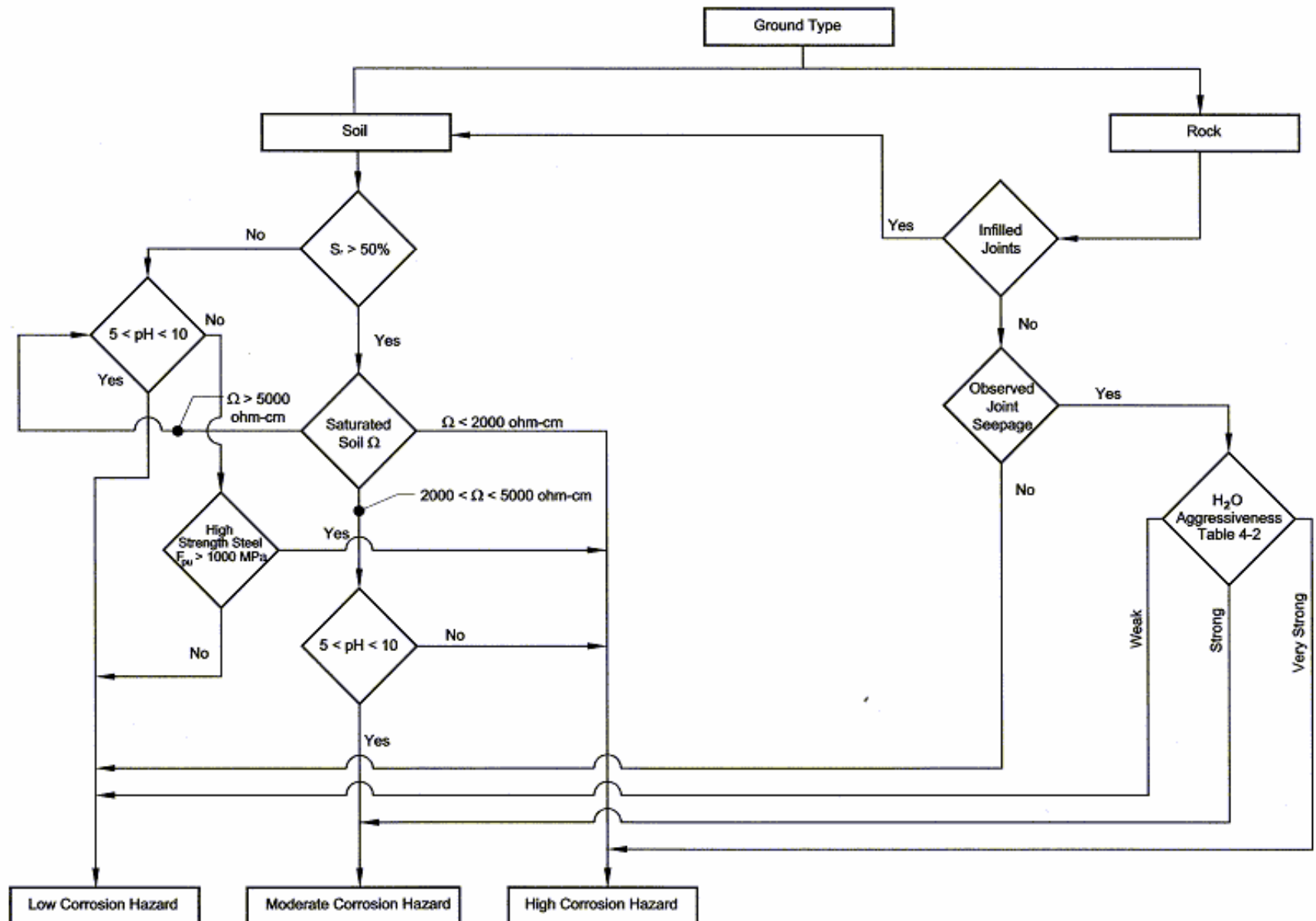
Photo of Ultrasonic Test



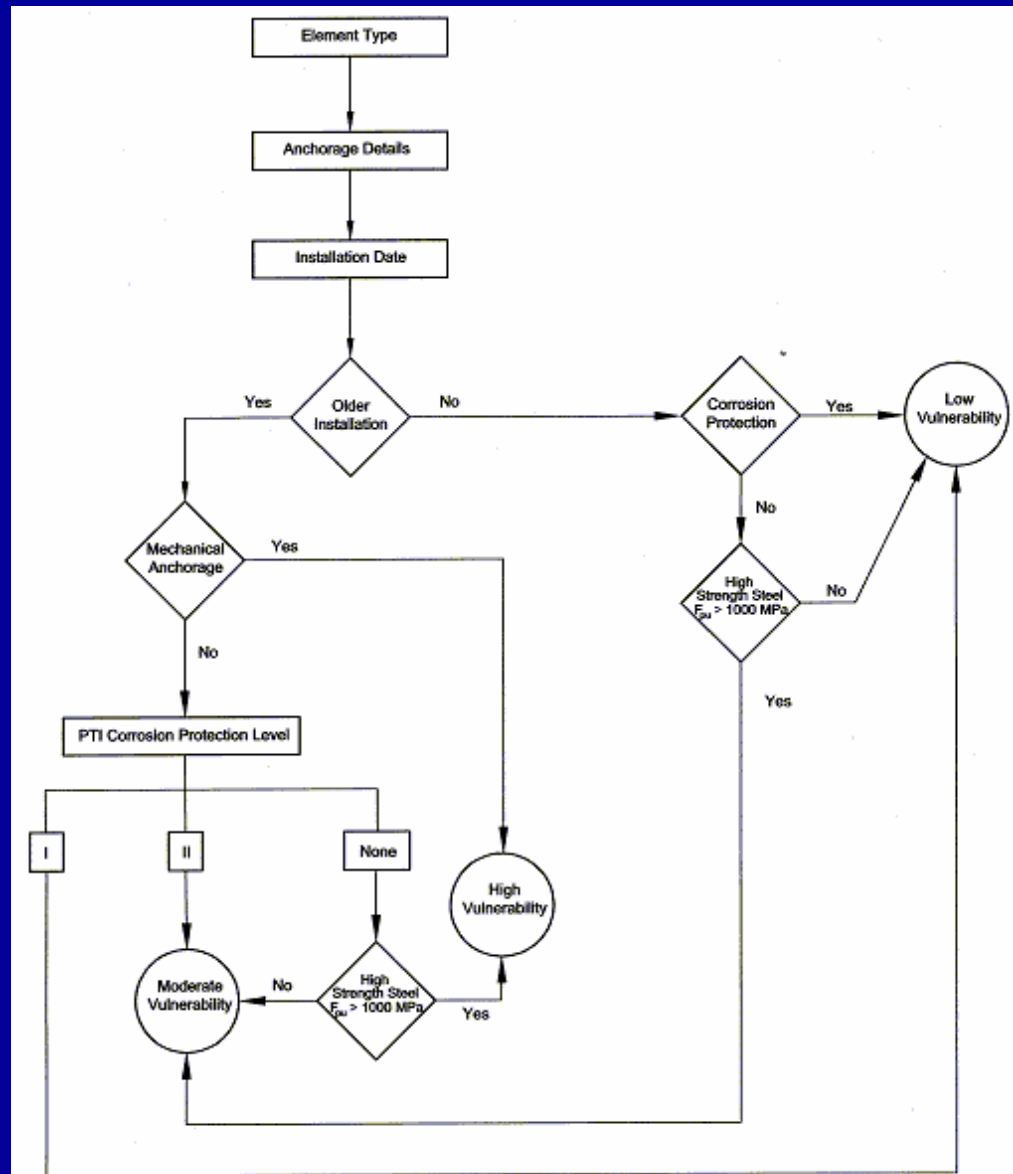
Ultrasonic Transducer (Bottom View)



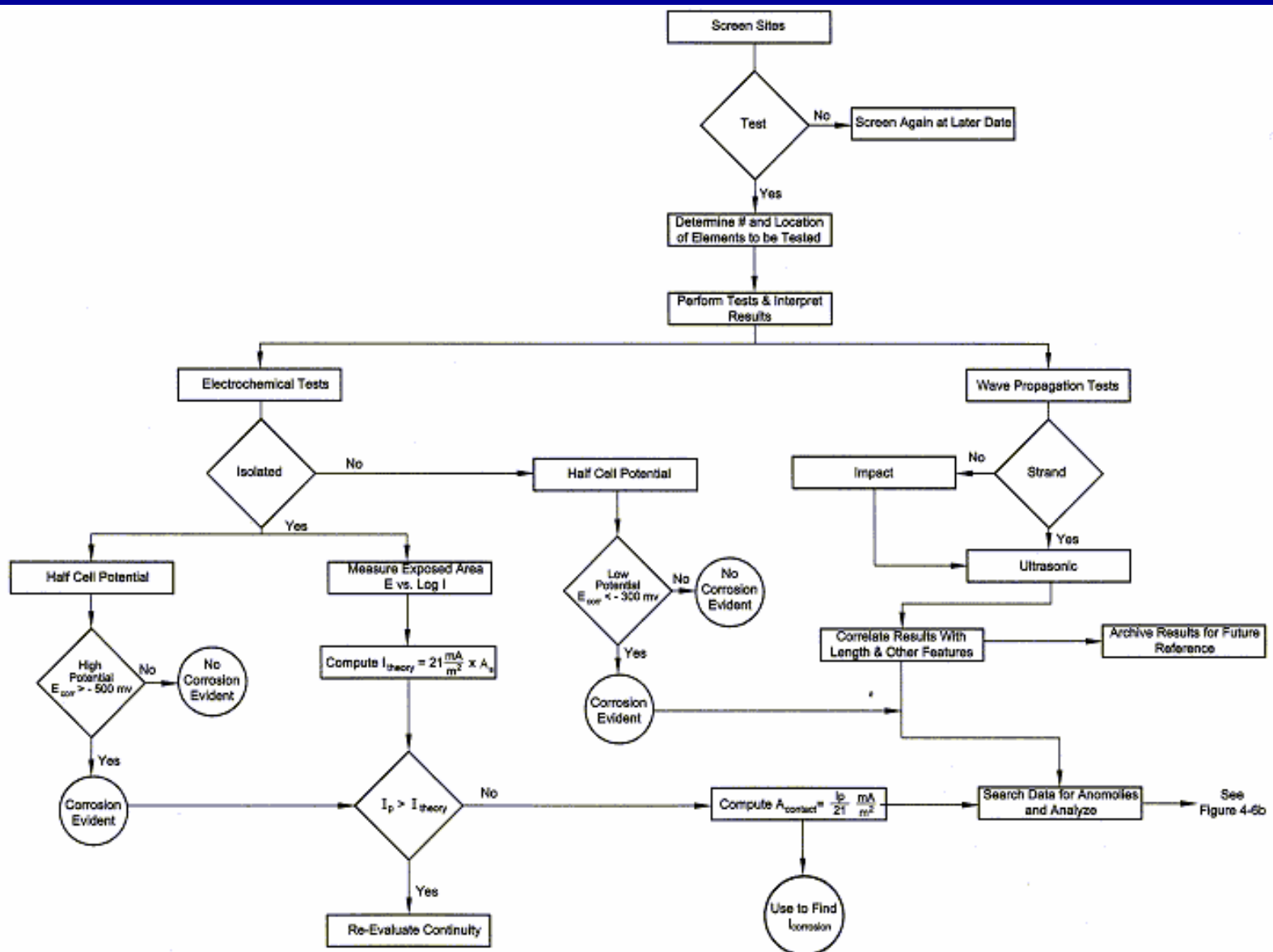
Decision Tree for Ground Hazard



Decision Tree for Vulnerability to Corrosion and Loss of Resistance



Decision Tree for Condition Assessment and Service Life Evaluation



Decision Tree for Condition Assessment and Service Life Evaluation

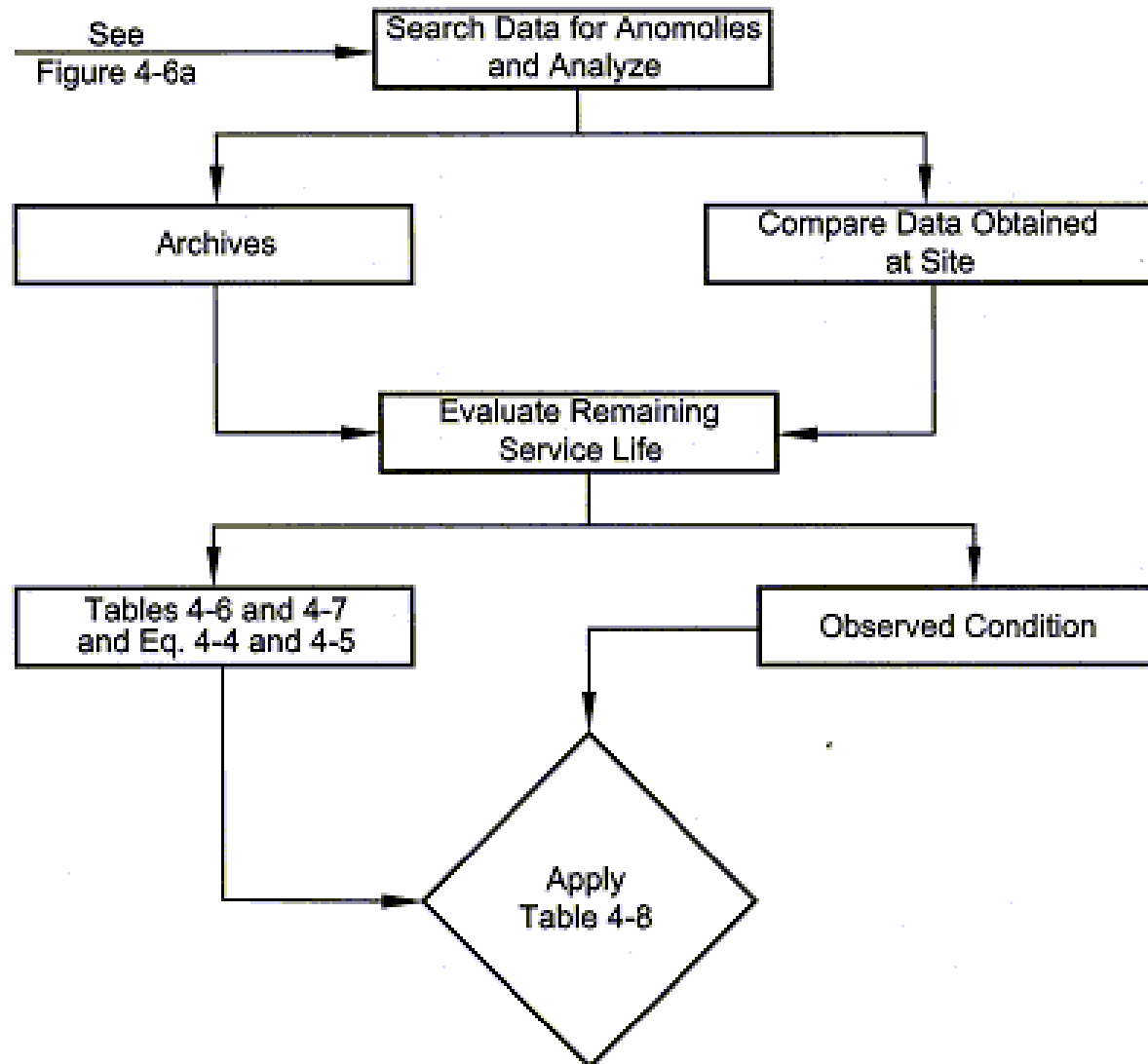


Table 4-6: Corrosiveness of Soils

Corrosiveness	Resistivity (ohm/cm)	pH
Normal	2000 – 5000	5 – 10
Aggressive	700 – 2000	5 – 10
Very Aggressive	< 700	< 5

**Table 4-7: Recommended Parameters
for Service-Life Prediction Model**

Parameter	Normal	Aggressive	Very Aggressive
K (μm)	35	50	340
n	1.0	1.0	1.0

Table 4-8: Recommended Action Plan

Case 1: No Distress - Loss < 25%

Case	Conditions	Recommended Action Plan
1	<ul style="list-style-type: none">• No distress observed with NDT• Service life prediction model estimates <25% loss of bar cross section• For strand elements, corrosion assessment model indicates hydrogen embrittlement and corrosion stress cracking not likely	<ul style="list-style-type: none">• Replacement of existing elements not recommended• If test results indicate grout does not reach back of element plates, grout void• Future monitoring recommended at a selected monitoring interval based on anticipated service life

Table 4-8: Recommended Action Plan

Case 2: No Distress - Loss > 25%

Case	Conditions	Recommended Action Plan
2	<ul style="list-style-type: none">• No distress observed with NDT• The service life prediction model estimated > 25% loss of bar cross section• For strand elements, corrosion assessment model indicates hydrogen embrittlement and corrosion stress cracking are likely	<ul style="list-style-type: none">• Verify results of NDT with invasive observations• If verified, continue monitoring• Reduction in testing frequency may be considered

Table 4-8: Recommended Action Plan

Case 3: Distress - Loss < 25%

Case	Conditions	Recommended Action Plan
3	<ul style="list-style-type: none">• Distress observed with NDT• Service life prediction model estimates < 25% loss of bar cross section• For strand elements, corrosion assessment model indicates hydrogen embrittlement and corrosion stress cracking are not likely	<ul style="list-style-type: none">• Apply acceptance criteria described in Standard Guide• If existing condition is deteriorated below acceptance criteria, verify NDT with invasive observations• If NDT results are confirmed, retrofit and increase testing frequency

Table 4-8: Recommended Action Plan

Case 4: No Remaining Service Life

Case	Conditions	Recommended Action Plan
4	<ul style="list-style-type: none">• Observations and service life prediction models are consistent with conclusion of no remaining service life	<ul style="list-style-type: none">• Confirm results from NDT with invasive observations• If confirmed, retrofit

CORROSION ISSUES FOR HIGH STRENGTH STEEL

- **Stress Corrosion Cracking**
 - Vulnerable at high prestress levels
- **Hydrogen Embrittlement**
 - Vulnerable at low Ph
- **Stray Current Corrosion**
- **Microbacterial Induced Corrosion**
 - Some grease products may promote microbacterial activity in the presence of moisture

SPECIAL MONITORING TECHNIQUES FOR STRAND-TYPE GROUND ANCHORS

- **Install Probe Holes**
 - Electrode placement and electrochemical testing
 - Acoustic emission sensors to detect wire breaks
- **Instrument Tendons**
 - Load cells
 - Strain gages for impact testing
 - VETEK System
- **Periodic Lift-off Testing**
- **Install Dummy Tendons For Inspection**

Questions?